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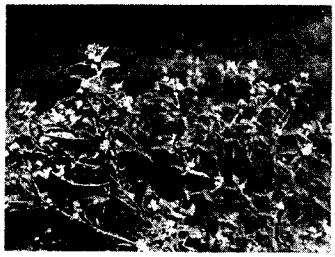

ENVIRONMENTAL IMPACT RESEARCH PROGRAM

TECHNICAL REPORT EL-86-33

ANTELOPE BITTERBRUSH (*Purshia tridentata*)

Section 7.5.1, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

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A plant materials report on antelope bitterbrush (*Purshia tridentata*) is provided as Section 7.5.1 of the US Army Corps of Engineers Wildlife Resources Management Manual. The report was prepared as a guide to assist the Corps District or project biologist with the selection, cultivation, and management of suitable plant materials for wildlife and habitat development programs. Topics covered for bitterbrush include description, distribution, habitat requirements, wildlife value, establishment, maintenance, and cautions and limitations.

Antelope bitterbrush is a semievergreen native shrub that occurs predominantly on well-drained hillsides and slopes in the West. It is considered one of the most important western browse species for big game, especially mule deer (*Odocoileus hemionus*), and plants are also used for food and cover by a variety of other game and nongame wildlife.

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Diagnostic characteristics of bitterbrush are described, and ecotypic variation is discussed. Habitat requirements, including soil and moisture preferences, are described. Food and cover value is discussed for several big game animals, and wildlife species known to use bitterbrush are listed. Guidelines are provided for site selection, site preparation, propagule selection and treatment, planting methods, and maintenance of bitterbrush stands. Tolerances to competition, burning, browsing pressure, and insect damage are discussed.

PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. Dave Mathis, Water Resources Support Center.

This report was prepared by Mr. Clinton H. Wasser, Professor Emeritus, Range Science Department, Colorado State University, Fort Collins, Colo.; Dr. Phillip L. Dittberner, US Fish and Wildlife Service, Western Energy and Land Use Team (WELUT), Fort Collins, Colo.; and Mr. Chester O. Martin, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), US Army Engineer Waterways Experiment Station (WES). Mr. Martin, Team Leader, Wildlife Resources Team, WTHG, was principal investigator for the work unit. The original report was prepared by WELUT under an Interagency Agreement with WES. Ms. Cathy Short and Ms. Pam Hutton, WELUT, assisted with manuscript preparation, and Ms. Jennifer Shoemaker, WELUT, prepared the original drawings. Review and comments were provided by Dr. Wilma A. Mitchell, WTHG, and Mr. Larry E. Marcy, Texas A&M University.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger T. Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Publications and Graphic Arts Division (PGAD). Final drawings were prepared by Mr. David R. (Randy) Kleinman, Scientific Illustrations Section, PGAD, under the supervision of Mr. Aubrey W. Stephens, Jr.

COL Allen F. Grum, USA, was the previous Director of WES. COL Dwayne G. Lee, CE, is the present Commander and Director. Dr. Robert W. Whalin is Technical Director.

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NOTE TO READER

This report is designated as Section 7.5.1 in Chapter 7 -- PLANT MATERIALS, Part 7.5 -- WOODY SPECIES, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 7.

ANTELOPE BITTERBRUSH *(Purshia tridentata)*

Section 7.5.1, US ARMY CORPS OF ENGINEERS
WILDLIFE RESOURCES MANAGEMENT MANUAL

Antelope bitterbrush (Family Rosaceae) is a semievergreen native shrub that occurs predominantly on well-drained hillsides and slopes in the West. Bitterbrush, also referred to as buckbrush or antelopebrush, is considered one of the most important western browse plants for big game, especially mule deer (*Odocoileus hemionus*); plants also provide nutritious forage for livestock. Bitterbrush is used for cover by songbirds and several species of game birds, and plant parts are commonly eaten by small mammals (Elmore 1976, Giunta et al. 1978). The species is considered valuable for controlling soil erosion (Thornburg 1982) and has good potential for landscape plantings because of its many growth forms (USDA Forest Service, undated).

DESCRIPTION

Bitterbrush grows from 3 to 6 ft (9 to 18 dm) tall and may be of either low-spreading or erect growth form. Plants are often intricately branched from twisted trunks, and main branches are sometimes layered. Heavily browsed plants may be altered into hemispheric, club, or mushroom shapes. The roots are finely branched and fibrous, and vary greatly in depth (Wasser 1982).

Numerous twigs produce relatively sparse foliage (Fig. 1), and plants appear silvery to gray from a distance (Elmore 1976). The simple wedge-shaped

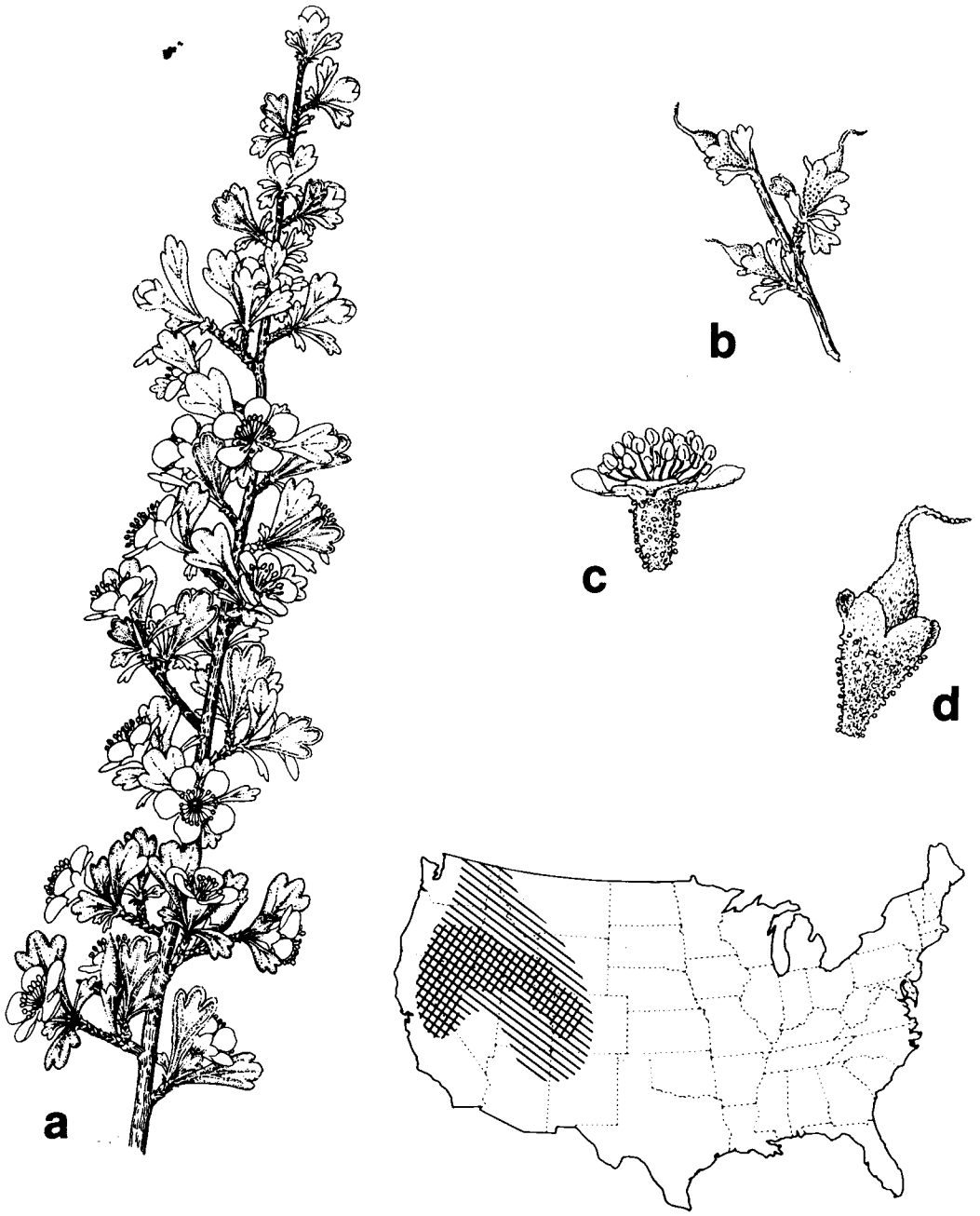

Figure 1. Distribution and distinguishing characteristics of antelope bitterbrush (*Purshia tridentata*): (a) flowering branch, (b) tip of fruiting branch, (c) flower, and (d) fruit (after Elmore 1976, and Wasser 1982). The map shows the overall species distribution (diagonal lines) and region of greatest management use (crosshatching)

leaves are 0.2 to 1.2 in. (5 to 30 mm) long and have weakly revolute (turned under) margins, 3-lobed tips, dark green upper surfaces, and gray-green finely pubescent undersurfaces. Leaves are normally deciduous, but some forms may retain most of their leaves throughout the winter. The miniature flowers are borne singly on short, lateral branchlets and have a funnel-shaped 5-lobed calyx tube and 5 creamy to butter-yellow petals (Harrington 1964). Tiny stalked glands occur on the base of the calyx. The fruit is a densely hairy, grooved, spindle-shaped achene that contains 1 or 2, rarely more, black seeds about the size of wheat grains (Elmore 1976, Wasser 1982). The species reproduces primarily from seed, but some of the low-spreading forms will reproduce vegetatively by layering (Nord 1965).

Antelope bitterbrush is highly polymorphic, and considerable ecotypic variation occurs throughout its range. The species readily hybridizes with Stansbury cliffrose (*Cowania mexicana stansburiana*) and may cross with other closely related species. Desert bitterbrush (*Purshia glandulosa*) is considered by some researchers to be a stabilized hybrid of antelope bitterbrush and Stansbury cliffrose (USDA Forest Service, undated).

DISTRIBUTION

Bitterbrush is native to the Intermountain West and adjacent regions and occurs generally, although often in a disjunct pattern, from western Montana south along the slopes of the Rocky Mountains to northern New Mexico and Arizona, west across the Great Basin to eastern California, and northward into southern British Columbia (Wasser 1982). Areas of major and minor occurrence are shown in Figure 1. In the Intermountain region the species commonly grows at elevations from 4000 to 8000 ft, but it is sometimes found below 1000 ft in the Pacific Coast States and has been recorded at 11,000 ft in the Sierra Nevada Mountains (Giunta et al. 1978).

HABITAT REQUIREMENTS

Antelope bitterbrush seldom grows in pure stands but usually occurs in mixed shrub and chaparral communities in (1) intermountain cool desert, foothill, and mountain brushlands; (2) juniper, pinyon, and oak woodlands; and (3) open aspen, pine, and fir forests. Bitterbrush commonly grows in association with sagebrush (*Artemisia* spp.), rabbitbrush (*Chrysothamnus* spp.), serviceberry (*Amelanchier* spp.), and mountain mahogany (*Cercocarpus* spp.).

The species is adapted to semiarid to subhumid climates, can withstand drought, and is generally cold tolerant. Plants are weakly shade tolerant, and growth is best in full sunlight (Giunta et al. 1978, Wasser 1982). Soil and moisture requirements are described below; tolerances to fire, competition, grazing, and other factors are discussed in the sections on maintenance and on cautions and limitations.

Soils

Bitterbrush occurs on soils of either igneous or sedimentary origin and is rather common on granitic sites. Plants will tolerate a wide range of soil textures, but the most vigorous and productive stands occur in moderate to deep, well-drained sandy or silty soils. Good stands on shallower soils require coarse, porous, and/or fractured subsoils. The species will grow on clayey soils but cannot tolerate heavy clays. Bitterbrush can tolerate a pH range from 5.5 to 8.5, but plants are best adapted to sites that are neutral to slightly acidic (pH 6.5 to 7.0) in the top 4 ft of soil. Plants are less frequent on moderately acid or alkaline soils and are relatively intolerant of saline, calcareous, or sodic soils (Nord 1965, Giunta et al. 1978, Wasser 1982). Nord (1965) found that bitterbrush was not present in California where soils were basic and calcareous within 4 ft of the surface.

Moisture

Mean annual precipitation is between 10 and 40 in. (normally less than 20 in.) within most of the species range, but there is much regional variation in the seasonal peak of moisture. Plants exhibit good drought tolerance and survival, but twig growth and fruiting may be affected by moisture stress. While roots may occasionally extend to a water table or to the capillary fringe above it, the species is generally intolerant of water tables within 6 to 10 ft of the soil surface (Shaw and Cooper 1973). Flooding and submergence for more than 1 or 2 weeks will kill most plants.

WILDLIFE VALUE

The leaves, buds, and small twigs (leaders) of bitterbrush are selected for forage by mule deer, pronghorn, elk, bighorn sheep, and moose.* Browsing

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* Scientific names are given in Table 1.

by deer, elk, and bighorn occurs chiefly during the winter when shrubs are not covered by snow (Hoskins and Dalke 1955). Pronghorns consume bitterbrush year-round, but there is less concentrated seasonal use (Mason 1952). Domestic livestock also use bitterbrush range and may compete with big game if sites are not properly managed (see sections on management and on cautions and limitations).

Several studies have shown bitterbrush to be heavily browsed by mule deer in fall and winter (Edwards 1942, Hoskins and Dalke 1955, Leach 1956, Wilkens 1957, Richens 1967), and use has been correlated with high nutrient content of the leaders (Smith and Hubbard 1954, Bissell et al. 1955, Dietz et al. 1962). Burrell (1982) examined diets of mule deer in relation to bitterbrush abundance in eastern Washington and found that use was heaviest from December through February (averaging as high as 86% on bitterbrush-dominant sites) and decreased substantially in the spring. Decreased use was not related to declining preference but appeared to be directly related to availability of palatable browse.

Bitterbrush forage is moderately nutritious and leaves are markedly more nutritious than twigs. The nutritive content of forage is relatively higher during the growing season and lower during dormancy. A test in California showed 11% crude protein for the forage in summer and 7% in winter; the lower figure was considered adequate for winter maintenance of deer except when herds were stressed by winter storms (Biswell and Strong 1955). Digestibility trials in California, Utah, and Colorado indicate that the total digestibility of nutrients in bitterbrush varies from 31% to 56% (Giunta et al. 1978). Percentages of nutrients are somewhat lower in bitterbrush than in its common associate, sagebrush, but their fiber contents are equal; bitterbrush has 5% to 10% more carbohydrate and is also moderately high in fat content (Short et al. 1966).

Bitterbrush also provides food and cover for several species of game birds, songbirds, and small mammals (Table 1). Rodents and rabbits often use the bark, stems, seeds, and roots for food and nesting material (Martin et al. 1951, Giunta et al. 1978). Some rodents, especially ground squirrels, disseminate bitterbrush seeds by storing them in caches; resource managers in California have estimated that the seeds may be spread as far as several hundred feet from the source. When caches are left uneaten, they can result in stand regeneration or extension into new areas (Hormay 1943). Rodents can

Table 1. Wildlife species known to use bitterbrush as food and/or cover (adapted from Martin et al. 1951, Giunta et al. 1978)

Species	Forage				
	Twigs, foliage	Roots	Bark	Seeds	Cover
Big Game					
Bighorn sheep (*Ovis canadensis*)	X				X
Elk (*Cervus elaphus*)	X				X
Moose (*Alces alces*)	X				
Mule deer (*Odocoileus hemionus*)	X				X
Pronghorn (*Antilocapra americana*)	X				X
Small mammals					
Cottontail rabbits (*Sylvilagus* spp.)	X		X		
Jackrabbits (*Lepus* spp.)	X		X		X
Least chipmunk (*Eutamias minimus*)	X		X		
Ground squirrels (*Spermophilus* spp.)	X		X	X	X
Golden mantled ground squirrel (*S. lateralis*)	X		X	X	X
Pocket gophers (*Thomomys* spp.)	X	X	X	X	X
Pocket mice (*Perognathus* spp.)	X	X	X	X	X
Deermice (*Peromyscus* spp.)	X	X	X	X	X
Voles (*Microtus* spp.)	X		X		X
Birds					
Blue grouse (*Dendragapus obscurus*)	X				X
Chukar partridge (*Alectoris chukar*)					X
Gray partridge (*Perdix perdix*)					X
Ruffed grouse (*Bonasa umbellus*)	X				X
Songbirds					X

also cause considerable damage to bitterbrush stands by shredding bark and girdling stems (see sections on cautions and limitations).

ESTABLISHMENT

Site Selection

Open range sites with sandy loam or coarser soils at least 3 ft deep are best for establishing bitterbrush. The location should have good drainage and must be above the zone of potential flooding. Slopes must not be too steep to allow the safe and proper use of equipment, and southern exposures should be

avoided because they dry out too quickly for good establishment (Plummer et al. 1968, Giunta et al. 1978).

Establishment in woodlands is generally successful only when park-like openings exist or when trees are widely spaced. Conifer stands should have a canopy cover of less than 30% and a basal area of less than 50 sq ft/acre. Stands of sagebrush and other shrubs can be seeded to bitterbrush if the existing stands are thinned and competition is reduced. Bitterbrush can also be sown or transplanted on disturbed sites such as roadcuts or on burned sagebrush and cheatgrass (*Bromus tectorum*) range.

Site Preparation

Plot design. Rangeland seeding projects should involve fewer than 1000 acres in order to make the project area accessible for management activities and minimize impacts on wildlife (Kindschy et al. 1982). Whenever feasible, revegetated plots should be elongated and have irregular perimeters to increase edge. Plots should be designed so that ground equipment used in site preparation and seeding is operated on the contour as much as possible (Williamson and Currier 1971).

Mechanical treatment. Site and seedbed preparation for bitterbrush often requires the use of equipment adapted to rough terrain. Brushland plows, cables, anchor chains, or pipe harrows pulled behind tractors may be necessary to thin existing brush cover and other perennial vegetation. Annuals can be controlled by disking or scalping prior to seeding.

Soil amendments. Application of fertilizer is seldom economical or cost effective in rangeland seeding activities, particularly in arid and semiarid zones. Mulching often increases the germination rate and survival of seedlings (Springfield 1972), but the cost is usually prohibitive. However, the cost of mulching may be warranted for disturbed land stabilization on steep slopes, exposed banks, and on other critically erosive sites. The mulch must be anchored with erosion control netting or chemical adhesives on steep slopes, windy exposures, and in areas subject to torrential rainfall (Giunta et al. 1978).

Propagules

Either seeds or seedlings may be used to establish bitterbrush. Seed is usually easier to obtain, and the cost of seeding is about half that of using transplants. Ten years are usually required to develop a dependable forage

supply from seed, whereas only 5 years are needed for plants to mature from transplants. Therefore, transplants should be used for soil erosion projects and where more rapid establishment of forage crops is critical.

Seed selection. Seed quality is not generally standardized for bitterbrush, but quality seed should test at least 90% purity, 85% germination, 76% pure live seed, and 15,400 cleaned seed/lb (Plummer et al. 1968, Giunta et al. 1978, Vories 1981, Wasser 1982). Growth responses and habitat tolerances vary greatly among seed from different sources. Only seed from an ecotype that is adapted to a site should be used, and if possible, seed should be test-planted nearby on the same habitat type. Ecotypes that layer and have occurred on the site being planted are preferred where wildfires are frequent. Seeding success is usually greater when the seed source is close to the planting location. However, seed collected up to 100 miles northward and 1000 ft higher in elevation is often adaptable (Plummer et al. 1968, Giunta et al. 1978).

Germination and vigor. The rate of germination for bitterbrush seed is highly variable in lab testing. Approximately 33% to 67% of seeds germinate in 14 to 15 days, but many do not complete germination for 30 days unless pretreated by moist chilling at 35° F for 1 to 3 months. Field evaluations by Plummer et al. (1968) in Utah have rated germination very good, initial establishment good, rate of growth average, and final establishment good; this suggests at least average seedling vigor. When planting in spring and summer, best germination is achieved if seeds are pretreated with a 3% thiourea solution for 5 min, then allowed to dry.

Planting Methods

Seeding. Bitterbrush can be planted from November to April in most regions. Late fall and early winter are best because colder temperatures subject seeds to a natural stratification process, thus increasing germination. Seeds planted in fall also develop faster than those planted in spring. In areas where rainfall is predominant in spring and summer, seed should be sown just before the expected wet season. During favorable growing seasons, satisfactory stands will result when seed is drilled at a rate of 6 to 8 lb/acre to a depth of 1 in. (Hubbard et al. 1959). Optimal seed depths range from 0.5 to 1.5 in. depending on soil texture, firmness of seedbed, moisture, and frost-heaving problems on certain soils (Hubbard 1956, Basile and Holmgren 1957, Vories 1981).

Seeds can be planted in rows with a rangeland drill or Hansen scalper-seeder, or they can be broadcast by hand-operated cyclone-seeders, mechanized ground seeders, or by airplane. Drill seeding is best adapted to sites that are relatively clear of vegetation and have slopes of 15 deg or less. These sites include recently abandoned farmland and burned rangeland. Using a scalper-seeder will minimize destruction to existing vegetation. Giunta et al. (1975) found that 24-in. scalped furrows resulted in better bitterbrush survival than narrower furrows.

Broadcasting seed is most successful on sites that have been scarified by appropriate ground equipment. Large tracts can be seeded by broadcasting seed in front of shallowly operated brushland plows or, more commonly, in front of cabling or anchor-chaining equipment. The seed should then be covered about 3/4 in. by harrowing or disking. Seed can also be aerially broadcast into a scarified seedbed containing mulch; with this method the seed lodges in depressions and becomes covered by natural settling of the soil. Broadcasting seed requires 50% to 100% more seed/acre than drilling to obtain equivalent stands.

Transplants. Seedlings are planted in the spring after the danger of killing frosts is past. Both container-grown and bare-rooted stock can be planted in furrows or holes large enough to accommodate all of the roots without crowding. Bare-rooted stock must be kept damp between lifting and replanting, watered when first set out, and watered occasionally during the first growing season. Potted plants should be watered before planting and as needed during the first growing season. Vegetation should be removed within a 2-ft radius of transplants (Giunta et al. 1978); small water retention basins around each plant are desirable.

Planting Mixtures

Bitterbrush is usually planted with other species in a seed mixture designed for habitat improvement. Between 1 and 3 lb bitterbrush seed/acre should be drilled or broadcast in a mixture that totals 10 to 20 lb seed/acre. Plummer et al. (1968) recommended seed mixtures of 18 to 23 species of grasses, forbs, and shrubs for improving game range in the mountain shrub vegetation type in Utah. Grasses should be included in bitterbrush plantings to stabilize the soil between widely spaced shrubs and to provide seasonal forage; bunchgrasses are more compatible in these mixtures and are less

competitive than sodforming grasses. At least 1 adapted legume should be included in the seed mixture to provide soil nitrogen.

It is often necessary to sow the grass and forb fractions of the mixture in separate drills or seeders to minimize competition. However, it is possible to drill with separators so that different species are planted in alternate rows or so that half of the drill sows one species while the other half sows a different species, thus producing alternate strips. Mixing seeds with varying proportions of rice hulls will provide a better flow of seeds through the equipment and result in a more uniform planting (Hubbard et al. 1959).

MAINTENANCE

While it is possible to establish a good stand of bitterbrush in 5 years, conservative management and monitoring of grazing pressures are needed until natural reproduction has begun; this usually does not occur until 8 to 10 years after seeding. Cattle should be excluded from revegetated areas for at least the first 2 or 3 years. An exception to this might be where cattle are stocked at 1/4 to 1/2 the normal grazing capacity to suppress grass competition (Giunta et al. 1978). Grazing pressure and percent use of current growth of bitterbrush should be monitored seasonally and annually. Foraging impacts of wildlife and livestock should be determined and necessary management adjustments made (Smith 1965). Range condition and vegetation composition assessments should be made at 3- to 5-year intervals.

Cropping, irrigating, and fertilizing bitterbrush stands are generally not cost effective. However, light irrigation the first 1 to 3 years will hasten stand establishment on eroded sites that need to be stabilized quickly. Once a balance has been achieved between forage production and use, grazing systems with livestock and wildlife can be modified to benefit desired forage species. Rotational deferment or rest-rotation grazing systems allow species a chance to restore vigor and reproduce. Cattle grazed at moderate levels in the spring can help release bitterbrush from grass competition (Giunta et al. 1978).

Dense sagebrush that suppresses bitterbrush can be controlled by spraying with low-volatile ester formulations of 2,4-D before plants are in full bloom. Mature bitterbrush is moderately tolerant to such sprays when they are applied before the flowering stage. However, the species is very sensitive to herbicidal sprays during the twig elongation stage of growth. Seedlings are less

tolerant of herbicides and will not tolerate dosages strong enough to control sagebrush (Hyder and Sneva 1962).

Mechanical methods can also be used to control the dominance of sagebrush in bitterbrush stands. Methods that sever or break the crowns of plants favor bitterbrush over the nonsprouting or weakly sprouting forms of big sagebrush (*Artemisia tridentata*). Cabling, pipe-harrowing, or chaining with anchor chains effectively snaps the brittle sagebrush (Giunta et al. 1978). A promising technique for rejuvenating old-growth stands of bitterbrush is to top their leaders with a chain saw; preliminary findings indicate that the resulting forage production is several times greater, and the growth stimulation lasts for about 3 years (Ferguson 1972).

CAUTIONS AND LIMITATIONS

Mature bitterbrush plants can compete with most other species except taller shrubs such as serviceberry and Gambel oak (*Quercus gambelii*). However, less palatable browse species, such as big sagebrush, may displace bitterbrush over time. Some of the more vigorous grasses, including crested wheatgrass (*Agropyron cristatum*), cheatgrass, and occasionally some of the native sod-forming grasses, may suppress seedling development of bitterbrush on disturbed or seeded ranges by exhausting soil moisture and utilizing a greater proportion of soil nutrients (Holmgren 1956, Hubbard and Sanderson 1961).

Bitterbrush is usually very intolerant of wildfire; however, certain ecotypes may sprout and recover after a fire. Erect forms may recover when the fire is quickly followed by adequate rainfall or when soil moisture is available in surface layers (Nord 1965). Decumbent, sprouting ecotypes of bitterbrush can sometimes be invigorated by burning where nonsprouting forms of big sagebrush are present and limit the production of bitterbrush. More precise prescriptions for local and regional burning practices may be obtained from agency handbooks and other available sources (Wright and Bailey 1982).

Bitterbrush is moderately tolerant of browsing pressure, and plants are markedly more tolerant during dormancy than when actively growing (McConnell and Garrison 1966). Thus, winter browsing is less injurious to bitterbrush than summer use. Clipping studies have shown that mature plants tolerate up to 50% removal of current annual twig growth without loss in vigor and productive capacity in winter (Garrison 1953, Shepherd 1971). However, only about

30% twig removal can be tolerated during the growing season. Thirty percent removal is sometimes prescribed to encourage natural reproduction and restoration of depleted bitterbrush stands (Giunta et al. 1978).

Rodents and insects have been known to cause extensive damage to bitterbrush range. Voles, in peak populations, can shred bark and damage large areas of shrubs (Mueggler 1967). Deermice can also do considerable damage by girdling bitterbrush stems (Gysel 1960). Great Basin tent caterpillars have been reported to defoliate large acreages of bitterbrush, but their damage does not result in complete kills. Other damaging insects are the mountain mahogany looper and the western tussock moth. Seeds are sometimes injured or destroyed by flower thrips, the bitterbrush seed midge, Say's stink bug, dark bitterbrush leaf tier, and the white-collared leaf tier. Cutworms and false wireworms kill seedlings. Crown dieback, root rot, and damping-off diseases have also been reported (Giunta et al. 1978, Wasser 1982).

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